Ray McLarney Inc.
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Subject: Reef Ball Suggestions for Perco Harbor Marina

It was a pleasure to meet you and Scott last week. For purposes of communication, this letter has been divided into five sections; 1) Computation of Recommendations, 2) Recommended Layout, 3) Mitigation Computations, 4) Special Specifications for Ordering, 5) Estimated Costs, 6) Other Considerations, and 7) Next Steps.

Computation of Recommendations

Using the copy of the CAD drawing by Ron Larson and Associates, Inc. (CADD FILE 174-MARINA) we estimated that the total liner feet for a Reef Ball breakwater/manatee exclusion barrier is about 1210 feet (allowing for a 33 foot opening). In a voice mail, you indicated to me that the existing oyster bed is 15,326 square feet with a cubic feet volume of 38,315.

Data on the following size Reef Balls in regards to square feet (footprint) and cubic volume (width X height X average girth) are as follows:

Ultra Ball = 30.25 square footprint, 99 cubic feet, 150 square feet [total surface area] (126 available to oysters) [surface area less bottom footprint]
Pallet Ball=16 square footprint, 42 cubic feet, 130 square feet (117 available to oysters)
Bay Ball= 9 square footprint, 15 cubic feet, 75 square feet (68 available to oysters)

Reef Ball Sizes, Weights, Volume & # of Holes

Style	Width	Height	Weight	Concrete Volume	Surface Area	# Holes
Ultra Ball	5.5 feet (1.70m)	4.2 feet (1.27m)	4000-6000 lbs (1814-2722 kg)	1 yard $0.76m^3$	150 ft^2 13.9 m^2	29-34
Reef Ball	6 feet (1.83m)	4 feet (1.22m)	3000-6000 lbs (1360-2722 kg)	0.75 yard $0.57m^3$	130 ft^2 12.1 m^2	29-34
Pallet Ball	4 feet (1.22m)	3 feet (0.9m)	1500-2200 lbs (680-998 kg)	0.33 yard $0.25m^3$	75 ft^2 7.0 m^2	17-24

Bay Ball	3 feet (0.9m)	2 feet (0.61m)	375-750 lbs (170-340 kg)	0.10 yard 0.08m³	30 ft² 2.8 m2	10-16
Mini-Bay Ball in development	2.5 feet (0.76m)	1.75 feet (0.53m)	150-200 lbs (kg)	less than 4 50 lb bags		8-12
Lo-Pro	2 feet (0.61m)	1.5 feet (0.46m)	70-100 lbs (kg)	less than 2 50 lb bags		6-10
Oyster	1.5 feet (0.46m)	1 foot (0.30m)	30-45 lbs (kg)	less than 1 50 lb bag		6-8

We analyzed the cost of each of our units in terms of square footprint and eliminated the use of the smaller sized Reef Balls as not being cost effective for your purposes. The Bay Ball provided the best cost/square footage ratio, with the Ultra and Pallet Ball being slightly more expensive per square footprint. However, we then analyzed the cubic feet we found the opposite relationship with the larger sizes being more cost effective.

Using these relative costing models, combined with the requirement of a complete barrier to Manatees (i.e. the need for a continuous row of Ultra Balls) and cost effective wave attenuation (i.e. Pallet Balls directly in front of the place where the Ultra Balls touch to dissipate wave energy between the larger units) we developed an "optimal configuration."

Recommended Layout (See CAD Drawing at end of letter)

Due to the softer sand/mud on the bottom, we recommend that the current oyster bed dredging be laid beneath the area to be filled with Reef Balls to a depth of between 4-10 inches. This will serve to level and stabilize the area and may provide some "seed" oysters to speed colonization of the Reef Balls by oysters.

The layout of the Reef Balls would then consist of three rows of Reef Balls comprising 3 sizes of Reef Balls. (Ultra Ball, Pallet Ball and Bay Ball in descending size order)

-The 1st Row (nearest to the marina) would contain Ultra Ball sized Reef Balls
-The 2nd Row would contain Pallet Ball sized Reef Balls
-The 3rd Row would contain Bay Ball sized Reef Balls

Therefore, in order to complete the entire 1210 feet would require a planning number of

-219 Ultra Balls
-219 Pallet Balls
-657 Bay Balls

(Assuming there is no extra linear space nor obsticals that would prevent the placement of Reef Balls in a linear fashion.)

Because some spacing is inevitable, we believe the above numbers represent the maximum units required. Our CAD drawing actually shows 213 Ultra Balls, 213 Pallet Balls, and 641 Bay Balls that is probably closer to the actual number of units that will be required.

Mitigation Computations

The planed number of units would occupy 16,041 Square Footprint and would have a volume of 40,734 Cubic Feet.

This provides a mitigation ratio of 1.047 (footprint) and 1.063 (cubic volume) to 1. (This allows for a safety margin above 1 in case the actual number of units is less than the planned number of units)

Although the footprint (square feet) of the oyster reef created by the Reef Balls would not be expected to grow, the cubic volume would be expected increase over time as the oysters colonize the surfaces and the Reef Balls grow in size. Because there is increased water flow within Reef Balls compared to the current oyster bed, we would expect the newly created reef to be healthier, faster growing and able to support more volume and numbers of living oysters in the long run.

The macro surface areas available for oyster colonization of the existing reef, given the square feet and cubic volume is 16,563 (assumes 2.5 feet average depth of the oysters as per your calculations).

Reef Balls provide the following Macro Surface area

Ultra Ball = 30.25 square footprint, 99 cubic feet, 150 square feet [total surface area] (126 available to oysters) [surface area less bottom footprint]
Pallet Ball=16 square footprint, 42 cubic feet, 130 square feet (117 available to oysters)
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To be conservative, we have removed the bottom surfaces which may not be good hosts for oysters and this still leaves 98112 square feet of active potential oyster growing surfaces.

Therefore the long-term oyster biological mitigation ratio is 5.916 to 1. It can be concluded that at a 17% colonization rate of oysters, the existing reef will be fully mitigated…higher rates of colonization (many of the Reef Balls in Tampa Bay which were used to create oyster reefs experience 95%+ colonization) would actually provide more living oysters than the existing reef.

There are additional, somewhat subjective, positive biological implications of this approach. The newly created Reef Ball oyster reef will have better spaces, voids and complexity for fish life. The newly created reef will also allow for better water flow to

the marina than would a barrier or natural oyster reef and this will create a better environment for marine life within the marina (i.e. higher dissolved oxygen levels and higher bay water exchange rates). Exclusion of manatees is also a benefit for protection of manatees from dangers present within the marina.

Special Specifications for Ordering

There are two concerns we have that may require advanced modifications to Reef Balls to insure the maximal probability of success. The first concern is the potential for the Reef Balls to subside (or sink) into the softer sand/mud on the site over time that would result in the loss of some of the active growing surfaces . In order to minimize this we have already recommended the use of the oyster dredging as a base to stabilize the area before deploying Reef Balls. Additionally, we recommend you order standard Reef Balls with the following modifications (which will not increase the cost of Reef Balls):

-Solid Bottoms: Reef Balls are standardly built with a hole in the middle of the bottoms to allow for some natural bottom structure for marine life. Eliminating this feature increases a Reef Ball's stability in softer bottom types (this has been demonstrated by the Georgia Department of Natural Resources and by other users of Reef Balls).

-Up to standard weight or lighter. We do not believe that movement of the units due to a storm is a consideration at Perco Marina due to the protection of the bay. Therefore, units can be either standard weight or lighter. Heavier units, often used in shallow water where storm energy is greatest would not provide any advantage and in fact may increase the chance of subsidence into the sand.

Secondly, based on your observations of oyster spat being in abundance at the site and the depth profile being ideal for oysters, we believe that, the oysters will settle on their own on the Reef Balls without additional assistance. However, there are methods to transplant oysters and other members of the fouling community onto Reef Balls if targeted colonization rates are not achieved. To make this process easy, attachment adapter plugs are pre-molded into the concrete. Although this process increases the cost of Reef Balls (very slightly), they could save thousands of dollars of attachment expense should it be determined in the future that you wish to undertake a transplant program. Typically, contractors charge about 10 cents per attachment adapter and the number of attachments are usually between 12 to 48 per Reef Ball (dependent upon size of the Reef Ball and planting density desired……if the balls for your project were outfitted with maximum attachment locations, the total cost of the project would only increase by $3,400). This is a very inexpensive "insurance" policy and therefore highly recommended.

Estimated Costs

The Reef Ball Development Group, Ltd. does not sell Reef Balls (we sell the molds and authorize contractors to do so) so your actual costs will depend upon which contractor you select.

The "suggested retail cost" of Reef Balls delivered to Perco Marina is $300 per Reef Ball, $180 per Pallet Ball and $80 per Bay Ball. However, in a project of this volume, Perco Marina could typically expect to obtain a 10-20% discount below these costs if the project is offered for open bidding or by direct negotiations with the authorized contractors. There are at least 2 Reef Ball Authorized Contractors (Reef Innovations, Inc. at 941-650-2519 and Coastal Reef Builders, Inc. 850-469-0734) that regularly do projects in the Sarasota/Bradenton area. I would expect, therefore, that you could obtain the Reef Balls with a budget of $125,000-140,000 (Full retail cost would be $157,680). (Factors affecting the cost include seasonality, volume, etc.…it is generally cheaper to purchase Reef Balls in the winter seasons than during the busier spring and summer months).

It is difficult for me to be specific in terms of the placement costs, it will depend on the season, how much depth is available at the time of installation (i.e. if a barge can be used and if so what size), etc. Both of the above companies can provide you with a turnkey quote to include installation. My best guess for planning purposes only and presuming there is depth for a barge would be to budget about $50,000 for deployment.

Other Considerations

There is a host of data and information available at www.artificialreefs.org should you need any additional product information such as concrete specifications, surface textures, hole sizes and placement, etc. There is a non-profit organization, called Tampa Bay Watch, that has used Reef Balls extensively to create oyster reefs near seawalls and docks. Capt. Peter A. Clark is the director and he can be reached at 727-896-5320 or pclark@tampabaywatch.org. Tampa Bay Watch may be a good resource for you if you need additional support information specific to oysters.

(Below, an Oyster Ball size Reef Ball deployed in Tampa Bay for one year Oyster Colonization is at least 80% and is typical)

(Reef Balls along a seawall in Tampa Bay showing strong oyster growth after one year)

("Sea Squirts", a type of tunicate, are powerful filter feeders like oysters. Shown here in Sarasota Bay on a Bay Ball under a dock. Tunicates colonize more quickly than oysters and often serve as the major fouling communit y until the oysters establish themselves).

Because the area where you will be building the Reef Balls is within Perco Marina's submerged land lease, we assume that you will not require an artificial reef permit for the construction of this reef. However, if such a permit is determined to be required, Tom Maher of Marine Habitats, Inc. is well qualified to assist you in obtaining an artificial reef permit. Dr. Lee Harris of the Florida Institute of Technology is also available to do engineering studies if you wish to know the anticipated wave attenuation of the breakwater or the stability of the units given the wave climate in the area. Both of these are independent contractors that do not pay any fees to the Reef Ball Development Group and it is entirely up to you to choose these or other consultants for services. We recommend them only because of their familiarity with Reef Ball products that can reduce a consultant's learning curve to be more efficient for you.

Next Steps

Ray, I certainly enjoyed meeting with you and Scott last week. I would be happy to provide you with any further assistance you might need as the project proceeds so don't hesitate to call if you need something. When it comes time to put this out to bid, give me a call and I can give you some strategies to get the best price from the authorized contractors.

Sincerely,

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